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COMPARATIVE AND QUANTATIVE ANALYSIS OF VARIATION PATTERN IN CONCRETE MIXES DUE TO USE OF ADMIXTURES

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ABSTRACT

The present research focuses on the variation pattern in key ingredients due to use of Superplasticizer and fly ash in designed concrete ranging from M20 to M40. The purpose of this study is to find the impact of the admixtures on cement and water content, for sustainable concrete construction. The results of the research work concludes that there is a considerable saving in water and cement requirement due to use of Superplasticizer and fly ash. The main contribution of the work is to find out the quantum of material saved.

KEYWORDS: Admixture, Fly Ash, Superplasticizer, Key Ingredients of Concrete, Sustainable Concrete Construction, IS Code Mix Design

INTRODUCTION

The country is going through a face of rapid development and growth. Since India is growing country large investments are in infrastructure development. Concrete is the most widely use construction materials available. Concrete is the base for all types of construction. Huge quantity of concrete production is required due to such speed in growth. Concrete is the mixture of cement, fine aggregate and coarse aggregate with water. Out of this cement in concrete are the most important constituents and act as a binder in the concrete.

A significant fraction of CO_2 discharged into the atmosphere comes from industry point sources. Cement production alone contributes approximately 5% of global. Also due to construction work quantity of potable water for human requirement reduces rapidly, as well natural resources such as lime stone mines goes on decreasing due to manufacturing of cement for making concrete. Due to all above reason we need to reduce consumption of cement and water as concrete making materials. This research paper is prepared to give the idea for mixing of admixtures in concrete and its effect on various properties of concrete mix which ultimately gives the result about how much amount of water and cement content we can reduce in concrete mix using admixtures and attaining the same strength.

The basic functions of plasticizing and high-range water reducing admixtures used in cement materials are following:

- The reduction of W/C ratio while maintaining the initial consistency of concrete mixture constant
- The reduction of cement and water content without worsening the fluidity of concrete mixture and while sustaining the same value of compressive strength as for the control concrete,

- The change of concrete mixture consistency into more fluid while maintaining W/C ratio constant (no changes in basic content of concrete mixture) [A. Kapelko, 2006]

  The cement content in concrete is reduced with regard to three aspects:

- **Economical –** the cost of cement and the possibility of its usage in a smaller quantity,
- **Technical –** the danger of too big cement shrinkage occurrence. [A. Kapelko, 2006]
- **Environmental** - To reduce the anthropogenic greenhouse emission from Cement production plant and to save availability of potable water for human requirement, which is already less on earth.

Physical and chemical changes occur when admixtures such as accelerators, retarders, water reducers, and Superplasticizers are added to the cement - water system. Mechanisms of the action of admixtures, changes in water demand, viscosity, setting, slump loss, Shrinkage, kinetics of hydration, microstructure, strength and durability of fresh and hardened cement pastes can be explained by the interaction effects [V. S. Ramchandran, 1981].

The dosage requirements vary between 0.5 and 3 percent by weight of cement, depending on the type of admixture used. Normally the Superplasticizer is added to the truck mixer after it arrives at the jobsite and at the last convenient moment before discharge. Within 5 minutes or less the slump greatly increases and at this time the user can get the most advantage from the high fluidity of the concrete. The rate at which the slump decreases depends on the type and amount of Superplasticizer added, as shown in this article, which reports the results of a laboratory investigation of how Superplasticizers affect the workability, strength and durability of high-strength concrete has been analyzed [V.M Malhotra, 1978]. Effect of Super plasticizer on workability and strength of ready mixed concrete were discussed in [Anuradha Varshaney, Pratibha Singh, Kiran Prajapati 2013 and Saeed Ahmad, Muhammad Nawaz, Ayub Elahi 2005] while absorption behavior of PNS type Superplasticizers and its relation to fluidity of cement paste and the contribution of alkali sulphate on dispersing mechanism of PNS super plasticized cement pastes is explained in relation with initial slump and its loss has been investigated in [Byung-Gi Kim, Shiping Jiang, Carmel Jolicoeur, Pierre-Claude AõÈtcin;]

An experimental study on the effect of a newly developed modified Lignosulphonate (MLS) Superplasticizer on the workability retention and initial setting time of cement pastes in comparison to those of polycarboxylate (PCE) and naphthalene (SNF) Superplasticizers has been studied [Min-Hong Zhang, Kåre Reknes, 2010]. In the available literature referred there is lack of solid investigations into the influence of MLS type Superplasticizers and fly ash as an admixture on key ingredients of concrete and their variation pattern. The aim of this research paper is to present the results of investigations into cement concrete with admixture of Superplasticizer MLS and fly ash replacement in concrete mix of controlled consistency, focusing on the variation of key ingredients mainly cement and water content in concrete mixes for various grades designed as per norms of Indian Standard Code 10262:2009.

MOTIVATION

We know that there are variations in ingredients due to grade and uses of admixtures but no work found which gives information regarding comparative and quantitative variation pattern in ingredients and saving in valuable resources such as water and cement in concrete.

CONCRETE MIX PROPORTIONING AS PER IS 10262:2009

This standard provides the guide lines for proportioning concrete mixes as per the requirements using the concrete making materials including other supplementary matter also identified for this purpose. The proportioning is carried out to achieve Specified characteristics at specified age, workability of fresh concrete and durability requirements. This standard is applicable for ordinary and standard concrete grades only.

METHODOLOGY

The experimental work was carried out using basic ingredients of concrete coarse and fine aggregates, water and cement, with use of fly ash and Superplasticizer. The ingredients taken were as follow:

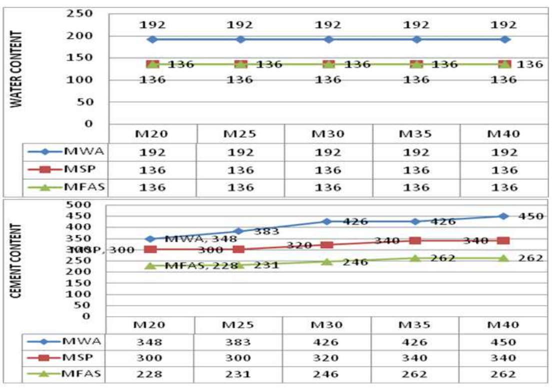
- **Coarse Aggregate:** Locally available coarse aggregate obtained from nandani quarry, consisting of natural rock of nominal maximum size of 20 mm and undersize with the existing grading, as supplied to construction sites was used.
- **Fine Aggregate:** Fine aggregate consisting of natural sand obtained from the Shivnath river, as supplied to the constructions site was used.
- **Cement:** Ordinary Portland Cement 43 grade conforming to IS 8112:1989 made of Ultratech was used for the experimental work.
- **Admixture:** Superplasticizer Pozzolith 225 (Modified lignosulphate) and fly ash is used as an admixture in concrete.

There are following 3 types of design mixes are prepared for grades M20, M25, M30, M35 and M40:

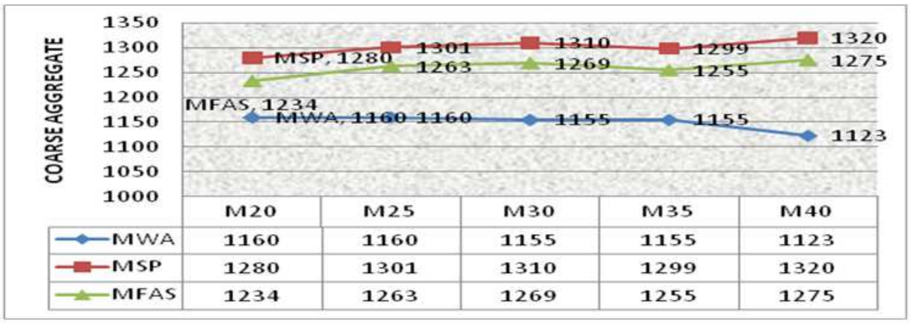
- Mix without any admixture (MWA)
- Mix with Superplasticizer pozzolith 225 (MSP)
- Mix with Fly Ash and Superplasticizer pozzolith 225 (MFAS)

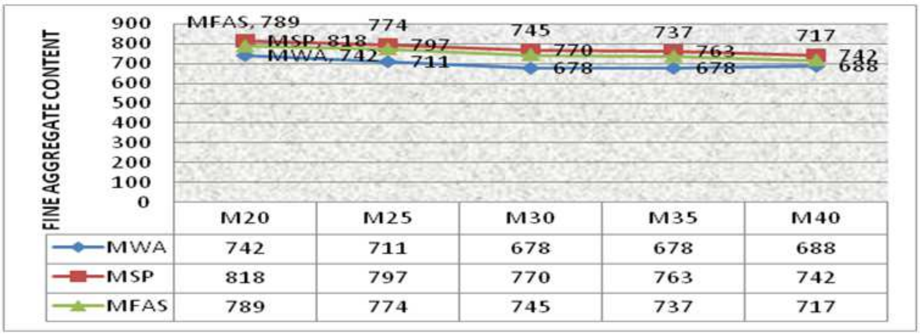
09 cubes of each grade of each type of mix are prepared. For every mix workability is calculated, and cubes are tested for 3, 7 and 28 days compressive strength to validate the result obtained.

RESULTS AND DISCUSSIONS

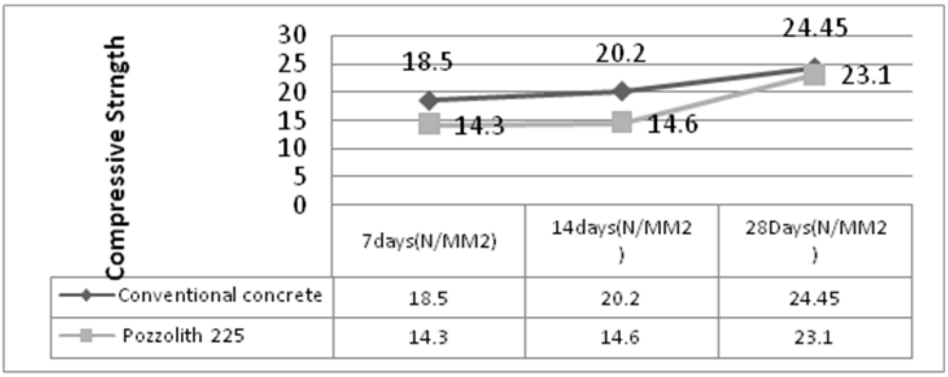


Graph 5.1: Showing Variation of Water Content (WC) and Cement Content(CC) with Grades of Concrete for Each Type of Mix

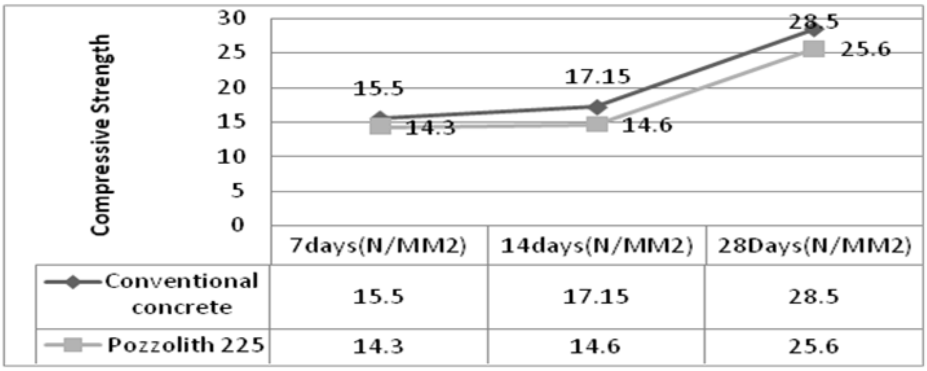




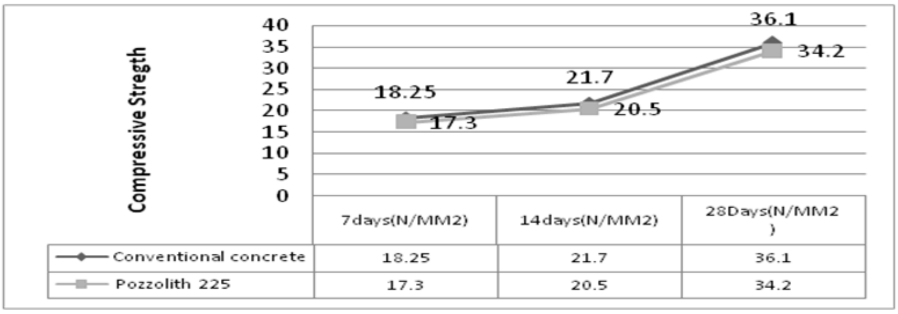
Graph 5.2: Showing Variation of Fine Aggregate Content and Coarse Aggregate Content with Grades of Concrete for Each Type of Mix



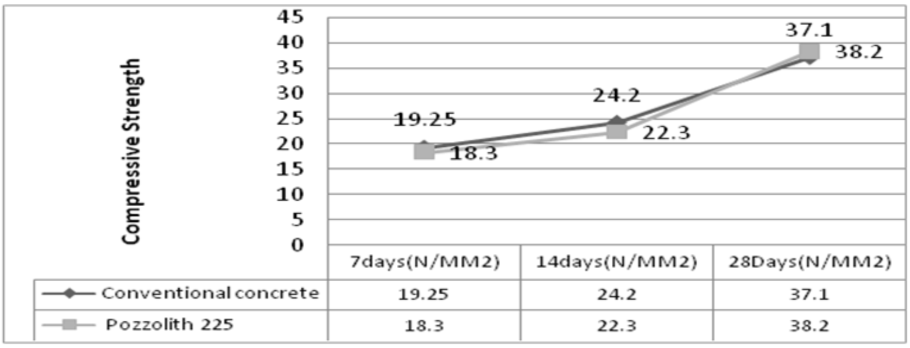
Graph 5.3: Showing Effect of Pozzolith 225 Superplasticizers on Compressive Strength Vs Conventional Concrete at Constant W/C Ratio for Mix M20 Grade



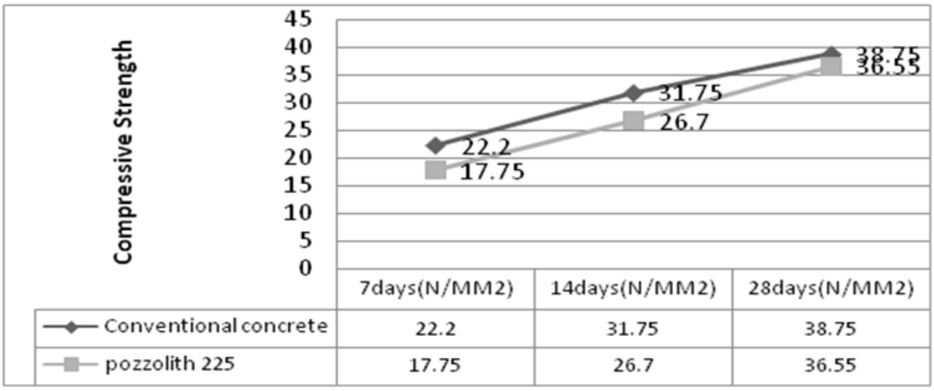
Graph 5.4: Showing Effect of Pozzolith 225 Superplasticizers on Compressive Strength Vs Conventional Concrete at Constant W/C Ratio for Mix M25 Grade



Graph 4.5: Showing Effect of Pozzolith 225 Superplasticizer on Compressive Strength Vs Conventional Concrete at Constant W/C Ratio for Mix M30 Grade



Graph 4.6: Showing Effect of Pozzolith 225 Superplasticizer on Compressive Strength Vs Conventional Concrete at Constant W/C Ratio for Mix M35 Grade



Graph 4.7: Showing Effect of Pozzolith 225 Superplasticizer on Compressive Strength Vs Conventional Concrete at Constant W/C Ratio for Mix M40 Grade

CONCLUSIONS

From the test on concrete mix with Superplasticizer of MLS (Modified Lignosulphate) family and Fly ash mix concrete following conclusion can be drawn:

- From the curved plotted between water content in concrete mix with admixture as a Superplasticizer Pozzolith 225 and fly ash content, and the conventional concrete it can be drawn that the water demand for concrete mix with fly ash and conventional concrete mix without any admixture is same and constant. Around 30% of water is reduced by plasticizers when used in concrete as compared to conventional one for same grade of concrete for constant water cement ratio.

- From the curve plotted between cement content and grade of concrete it is observed that-
  - Cement content can be reduced up to 14% and 34% for concrete with Superplasticizer and fly ash respectively when compared with conventional concrete of M20 grade.
  - 22% and 40 % cement content can be save in concrete paste with Superplasticizer and Fly ash respectively as compared to concrete without admixture in concrete grade M25.
  - 25% and 42% amount of cement is reduced when Superplasticizer and fly ash is used in concrete for grade M30 when compared with the conventional one.
  - Reduction of 20 % in concrete mix with Superplasticizer and 39 % in concrete mix with fly ash is observed for grade M35 of concrete.
  - 24% and 42% reduction of cement content is measured respectively for concrete mix with Superplasticizer and fly ash when compared with normal mix in grade M40.
  - Fly ash concrete mix reduce more cement than superplasticized concrete with average reduction of 39% but Maximum saving of cement is found for concrete grade M30 and M40 grade mix using Fly ash.
- From the graph between fine aggregate and grade of concrete it is observed that –
  - More fine aggregate is required for concrete mix with Superplasticizer and with fly ash when compared with mix without admixture.
  - Fine aggregate requirement increases for about 6-14% for superplasticized concrete.
  - For M40 grade of concrete excess fine aggregate requirement is relatively less(approx 4% to 8%) as compared to other grades of concrete when Superplasticizer and fly ash is used.
  - For M30 grade of concrete mix with fly ash maximum amount around 10% to 14% of fine aggregate requirement is increased as compare to other grade of superplasticized and fly ash mix.
- From curve plotted between coarse aggregate and grades grade of concrete following conclusion can be drawn-
  - More coarse aggregate is required for concrete mix with Superplasticizer and with fly ash when compared with mix without admixture.
  - Coarse aggregate requirement increases for about 10-18 % for superplasticized concrete.
  - For M40 grade of concrete excess coarse aggregate requirement is maximum (Approx.18%) and for M20 grade of concrete it is minimum (Approx. 6%) in part replaced fly ash concrete.
  - Coarse aggregate requirement increases for about 6-14 % for concrete mix with fly ash.
- From the curve plotted for comparison of strength of superplasticized concrete and conventional concrete it is concluded that the strength of conventional concrete is more than superplasticized concrete.

FUTURE SCOPE OF WORK

- To study the saving in actual quantum of ingredients of concrete by using different cementitious material like

RHA, GGBS, Silica fume etc.

- The comparative and quantitative analysis of ingredients due to families of new generation Superplasticizer such as Modified Lignosulphonate, Sulphonated Melamine Formaldehyde, Salphonated Naphthalene Formaldehyde, Carboxylated Acrylic Estar

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